Results of Proficiency Test
Cyclohexane
February 2020

Organized by: Institute for Interlaboratory Studies
                  Spijkenisse Netherlands

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CONTENTS

Appendices:

1   INTRODUCTION

Since 2018, the Institute for Interlaboratory Studies (iis) organizes a proficiency scheme for
Cyclohexane every year. During the annual proficiency testing program 2019/2020 it was
decided to continue the round robin for the analysis of Cyclohexane.
In this interlaboratory study 11 laboratories in 8 different countries registered for participation.
See appendix 2 for the number of participants per country.
In this report the results of this proficiency test for Cyclohexane are presented and discussed.
This report is also electronically available through the iis website www.iisnl.com.

2   SET UP

The Institute for Interlaboratory Studies (iis) in Spijkenisse, the Netherlands, was the
organizer of this proficiency test (PT). Sample analyzes for fit-for-use and homogeneity
testing were subcontracted to an ISO/IEC17025 accredited laboratory. It was decided to
send one sample of 1 L of Cyclohexane labelled #20012.
The participants were requested to report rounded and unrounded test results. The
unrounded test results were preferably used for statistical evaluation.

2.1   QUALITY SYSTEM

The Institute for Interlaboratory Studies in Spijkenisse, the Netherlands, has implemented a
quality system based on ISO/IEC17043:2010. This ensures strict adherence to protocols for
sample preparation and statistical evaluation and 100% confidentiality of participant's data.
Feedback from the participants on the reported data is encouraged and customer's
satisfaction is measured on a regular basis by sending out questionnaires.

2.2   PROTOCOL

The protocol followed in the organization of this proficiency test was the one as described for
proficiency testing in the report 'iis Interlaboratory Studies: Protocol for the Organisation,
Statistics and Evaluation' of June 2018 (iis-protocol, version 3.5). This protocol is
electronically available through the iis website www.iisnl.com, from the FAQ page.

2.3   CONFIDENTIALITY STATEMENT

All data presented in this report must be regarded as confidential and for use by the
participating companies only. Disclosure of the information in this report is only allowed by
means of the entire report. Use of the contents of this report for third parties is only allowed
by written permission of the Institute for Interlaboratory Studies. Disclosure of the identity of
one or more of the participating companies will be done only after receipt of a written
agreement of the companies involved.

2.4   SAMPLES

A batch of approximately 25 L of Cyclohexane was obtained from a local chemical supplier. After homogenization 25 amber glass bottles of 1 L were filled and labelled #20012. The homogeneity of the subsamples #20012 was checked by determination of Density at 20°C according to ASTM D4052 on 8 stratified randomly selected samples.

	Density at 20°C in kg/L
sample #20012-1	0.77855
sample #20012-2	0.77855
sample #20012-3	0.77857
sample #20012-4	0.77855
sample #20012-5	0.77855
sample #20012-6	0.77856
sample #20012-7	0.77856
sample #20012-8	0.77856

Table 1: homogeneity test results of subsamples #20012

From the above test results the repeatability was calculated and compared with 0.3 times the reproducibility of the reference test method in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Density at 20°C in kg/L
r (observed)	0.00002
reference test method	ISO12185:96
0.3 * R (reference test method)	0.00015

Table 2: evaluation of the repeatability of subsamples #20012

The calculated repeatability was lower than 0.3 times the reproducibility of the reference test method. Therefore, homogeneity of the subsamples was assumed.

To each of the participating laboratories one bottle of 1 L Cyclohexane labelled #20012 was sent on January 29, 2020. An SDS was added to the sample package.

2.5   STABILITY OF THE SAMPLES

The stability of Cyclohexane packed in amber glass bottles was checked. The material was found sufficiently stable for the period of the proficiency test.

2.6   ANALYZES

The participants were requested to determine on sample #20012: Acid Wash Color, Appearance, Color Pt/Co, Density at 20°C, Distillation (IBP, 50% recovered, DP and range), Freezing Point, Purity, Benzene, n-Hexane, Methylcyclohexane, Methylcyclopentane, Refractive Index at 20°C, Sulfur and UV Absorbance.

It was explicitly requested to treat the sample as if it was a routine sample and to report the test results using the indicated units on the report form and not to round the test results but report as much significant figures as possible. It was also requested not to report 'less than' test results, which are above the detection limit, because such test results cannot be used for meaningful statistical evaluations.

To get comparable test results a detailed report form and a letter of instructions are prepared. On the report form the reporting units are given as well as the appropriate reference test methods (when applicable) that will be used during the evaluation. The detailed report form and the letter of instructions are both made available on the data entry portal www.kpmd.co.uk/sgs-iis/. The participating laboratories are also requested to confirm the sample receipt on this data entry portal. The letter of instructions can also be downloaded from the iis website www.iisnl.com.

3 RESULTS

During five weeks after sample dispatch, the test results of the individual laboratories were gathered via the data entry portal www.kpmd.co.uk/sgs-iis/. The reported test results are tabulated per determination in appendix 1 of this report. The laboratories are presented by their code numbers.

Directly after the deadline, a reminder was sent to those laboratories that had not reported test results at that moment. Shortly after the deadline, the available test results were screened for suspect data. A test result was called suspect in case the Huber Elimination Rule (a robust outlier test) found it to be an outlier. The laboratories that produced these suspect data were asked to check the reported test results (no reanalysis). Additional or corrected test results are used for data analysis and the original test results are placed under 'Remarks' in the test result tables in appendix 1. Test results that came in after the deadline were not taken into account in this screening for suspect data and thus these participants were not requested for checks.

3.1 STATISTICS

The protocol followed in the organization of this proficiency test was the one as described for proficiency testing in the report 'iis Interlaboratory Studies: Protocol for the Organisation, Statistics and Evaluation' of June 2018 (iis-protocol, version 3.5).
For the statistical evaluation the *unrounded* (when available) figures were used instead of the rounded test results. Test results reported as '<…' or '>…' were not used in the statistical evaluation.

First, the normality of the distribution of the various data sets per determination was checked by means of the Lilliefors-test, a variant of the Kolmogorov-Smirnov test and by the calculation of skewness and kurtosis. Evaluation of the three normality indicators in combination with the visual evaluation of the graphic Kernel density plot, lead to judgement of the normality being either 'unknown', 'OK', 'suspect' or 'not OK'. After removal of outliers, this check was repeated. If a data set does not have a normal distribution, the (results of the) statistical evaluation should be used with due care.

According to ISO5725 the original test results per determination were submitted to Dixon's, Grubbs' and/or Rosner's outlier tests. Outliers are marked by D(0.01) for the Dixon's test, by G(0.01) or DG(0.01) for the Grubbs' test and by R(0.01) for the Rosner's test. Stragglers are marked by D(0.05) for the Dixon's test, by G(0.05) or DG(0.05) for the Grubbs' test and by R(0.05) for the Rosner's test. Both outliers and stragglers were not included in the calculations of averages and standard deviations.

For each assigned value the uncertainty was determined in accordance with ISO13528. Subsequently the calculated uncertainty was evaluated against the respective requirement based on the target reproducibility in accordance with ISO13528. In this PT, the criterion of ISO13528, paragraph 9.2.1. was met for all evaluated tests, therefore, the uncertainty of all assigned values may be negligible and need not be included in the PT report.

Finally, the reproducibilities were calculated from the standard deviations by multiplying them with a factor of 2.8.

3.2   GRAPHICS

In order to visualize the data against the reproducibilities from literature, Gauss plots were made, using the sorted data for one determination (see appendix 1). On the Y-axis the reported test results are plotted. The corresponding laboratory numbers are on the X-axis.

The straight horizontal line presents the consensus value (a trimmed mean). The four striped lines, parallel to the consensus value line, are the +3s, +2s, -2s and -3s target reproducibility limits of the selected reference test method. Outliers and other data, which were excluded from the calculations, are represented as a cross. Accepted data are represented as a triangle.

Furthermore, Kernel Density Graphs were made. This is a method for producing a smooth density approximation to a set of data that avoids some problems associated with histograms. Also a normal Gauss curve was projected over the Kernel Density Graph for reference.

3.3   Z-SCORES

To evaluate the performance of the participating laboratories the z-scores were calculated. As it was decided to evaluate the performance of the participants in this proficiency test (PT) against the literature requirements, e.g. ASTM or ISO reproducibilities, the z-scores were calculated using a target standard deviation. This results in an evaluation independent of the variation of this interlaboratory study.
The target standard deviation was calculated from the literature reproducibility by division with 2.8. In case no literature reproducibility was available, other target values were used. In some cases, a reproducibility based on former iis proficiency tests could be used.

When a laboratory did use a test method with a reproducibility that is significantly different from the reproducibility of the reference test method used in this report, it is strongly advised to recalculate the z-score, while using the reproducibility of the actual test method used, this in order to evaluate whether the reported test result is fit-for-use.

The z-scores were calculated according to:

z(target) = (test result - average of PT) / target standard deviation

The z(target) scores are listed in the test result tables in appendix 1.

Absolute values for z<2 are very common and absolute values for z>3 are very rare.
The usual interpretation of z-scores is as follows:

$$|z| < 1 \text{ good}$$
$$1 < |z| < 2 \text{ satisfactory}$$
$$2 < |z| < 3 \text{ questionable}$$
$$3 < |z| \quad \text{unsatisfactory}$$

4   EVALUATION

In this interlaboratory study some problems were encountered with dispatch of the samples
due to the COVID-19 crisis. Nine participants reported test results before the final reporting
date and two participants were not able to report any test results. Not all laboratories were
able to report all analyzes requested.
Finally, 9 participants reported 88 numerical test results. Observed were 5 statistically
outlying test results, which is 5.7%. In proficiency studies, outlier percentages of 3% - 7.5%
are quite normal.

Not all original data sets proved to have a normal Gaussian distribution. These are referred
to as "not OK" or "suspect". The statistical evaluation of these data sets should be used with
due care, see also paragraph 3.1.

4.1   EVALUATION PER TEST

In this section the test results are discussed per test. The test methods, which were used by
the various laboratories, were taken into account for explaining the observed differences
where possible and applicable. These test methods are also in the tables together with the
reported test results. The abbreviations, used in these tables, are explained in appendix 3.

In the iis PT reports, ASTM methods are referred to with a number e.g. D7266 and an added
designation for the year that the method was adopted or revised e.g. D7266:13e1. If
applicable, a designation in parentheses is added to designate the year of reapproval e.g.
D7266:13e1(2018). In the test result tables of appendix 1 only the method number and year
of adoption or revision e.g. D7266:13e1 will be used.

Acid Wash Color: Most reporting participants agreed on a value of 1- (-1).

Appearance: All participants agreed on the appearance which was bright and clear
                   (Pass).

Color Pt/Co: This determination was not problematic. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is in agreement with the requirements of ASTM D5386:16 or ASTM D1209:05(2019).

Density at 20°C: This determination was not problematic. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of ISO12185:96.

Distillation: This determination was not problematic. In total three statistical outliers were observed. However, all calculated reproducibilities after rejection of the statistical outliers are in agreement with the requirements of ASTM D850:18e1 for automated and manual modes.

Freezing Point: Only two participants reported a test result. Therefore, no z-scores were calculated.

Purity: This determination was not problematic. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of ASTM D7266:13e1(2018).

Benzene: This determination was not problematic. One statistical outlier was observed. However, the calculated reproducibility after rejection of the statistical outlier is in agreement with the requirements of ASTM D7266:13e1(2018).

n-Hexane: All participants agreed on a concentration lower than 5 mg/kg. The reproducibility mentioned in ASTM D7266:13e1(2018) for n-Hexane is given at a much higher concentration. Therefore, no z-scores were calculated.

Methylcyclohexane: This determination was not problematic. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of D7266:13e1(2018).

Methylcyclopentane: This determination was not problematic. No statistical outliers were observed but one test result was excluded. However, the calculated reproducibility after rejection of the suspect data is in agreement with the requirements of D7266:13e1(2018).

Refractive Index: This determination was not problematic. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of ASTM D1218:12(2016).

Sulfur: All reporting participants agreed on a concentration lower than 1 mg/kg. Therefore, no z-scores were calculated.

UV Absorbance: Regretfully, none of the participants reported test results.

4.2   PERFORMANCE EVALUATION FOR THE GROUP OF LABORATORIES

A comparison has been made between the reproducibility as declared by the relevant reference test method and the reproducibility as found for the group of participating laboratories. The number of significant test results, the average result, the calculated reproducibility (2.8 * standard deviation) and the target reproducibility derived from literature reference test methods (in casu ASTM, ISO test methods) are presented in the next table.

Parameter	unit	n	average	2.8 * sd	R(lit)
Acid Wash Color (acid layer)		4	1- (-1)	n.e.	n.e.
Appearance		7	Pass (B&C)	n.a.	n.a.
Color Pt/Co		8	2.0	1.4	4.9
Density at 20°C	kg/L	8	0.7786	0.0004	0.0005
Distillation, IBP	°C	5	80.4	0.4	0.6
Distillation, 50% recovered	°C	6	80.7	0.2	0.2
Distillation, Dry Point	°C	7	80.8	0.4	0.5
Freezing Point	°C	2	6.4	n.e.	n.e.
Purity of Cyclohexane	%M/M	8	99.981	0.005	0.007
Benzene	mg/kg	7	24.6	5.3	22.0
n-Hexane	mg/kg	8	<5	n.e.	n.e.
Methylcyclohexane	mg/kg	8	97	18	35
Methylcyclopentane	mg/kg	5	1.1	0.3	3.6
Refractive Index at 20°C		6	1.4263	0.0000	0.0005
Sulfur	mg/kg	8	<1	n.e.	n.e.

Table 3: performance evaluation sample #20012

Without further statistical calculations it can be concluded that for all of the tests there is a good compliance of the group of participating laboratories with the relevant reference test methods. The tests have been discussed in paragraph 4.1.

4.3   COMPARISON OF THE PROFICIENCY TEST OF FEBRUARY 2020 WITH PREVIOUS PTS

	February 2020	February 2019	March 2018
Number of reporting laboratories	9	10	10
Number of test results	88	104	120
Number of statistical outliers	5	2	10
Percentage of statistical outliers	5.7%	1.9%	8.3%

Table 4: comparison with previous proficiency tests

In proficiency tests, outlier percentages of 3% - 7.5% are quite normal.

The performance of the determinations of the proficiency test was compared against the requirements of the respective reference test methods. The conclusions are given the following table.

Parameter	February 2020	February 2019	March 2018
Acid Wash Color (acid layer)	n.e.	++	++
Color Pt/Co	++	+	+
Density at 20°C	+	++	++
Distillation	+	++	++
Purity of Cyclohexane	+	++	+
Benzene	++	++	++
n-Hexane	n.e.	-	-
Methylcyclohexane	+	++	+
Methylcyclopentane	++	++	--
Refractive Index at 20°C	++	-	+
Sulfur	n.e.	n.e.	n.e.
UV Absorbance	n.e.	n.e.	n.e.

Table 5: comparison determinations against the reference test methods

In the table above the following performance categories were used:
++ : group performed much better than the reference test method
+ : group performed better than the reference test method
+/- : group performance equals the reference test method
- : group performed worse than the reference test method
-- : group performed much worse than the reference test method
n.e. : not evaluated

APPENDIX 1
Determination of Acid Wash Color (acid layer) on sample #20012

lab	method	value	mark	z(targ)	remarks
171	D848	Pass			
311		-----			
323	D848	-1			
657	D848	1-			
847		-----			
859		-----			
963	D848	1-			
1081		-----			
1954		-----			
6262	D848	1-			
6315		-----			
	n	4			
	mean (n)	1- (-1)			

Determination of Appearance on sample #20012

lab	method	value	mark	z(targ)	remarks
171	E2680	Pass		-----	
311		-----		-----	
323	E2680	clear and bright		-----	
657	E2680	Pass		-----	
847		-----		-----	
859		-----		-----	
963	Visual	Clear		-----	
1081		-----		-----	
1954	Visual	Clear and colorless		-----	
6262	Visual	Clear and Bright		-----	
6315	Visual	clear, bright			

n	7	
mean (n)	Pass (B&C)	

Determination of Color Pt/Co on sample #20012

lab	method	value	mark	z(targ)	remarks
171	D1209	2		-0.01	
311	D5386	2		-0.01	
323	D5386	2		-0.01	
657	D5386	2.62		0.34	
847		-----		-----	
859		-----		-----	
963	D1209	2		-0.01	
1081	D5386	2		-0.01	
1954	D1209	4	D(0.01)	1.13	
6262	D5386	2.5		0.28	
6315	DIN EN ISO 6271	1		-0.58	

	normality	not OK
	n	8
	outliers	1
	mean (n)	2.01
	st.dev. (n)	0.483
	R(calc.)	1.35
	st.dev.(D5386:16)	1.754
	R(D5386:16)	4.91
Compare:		
	R(D1209:05(2019)	7

Kernel Density
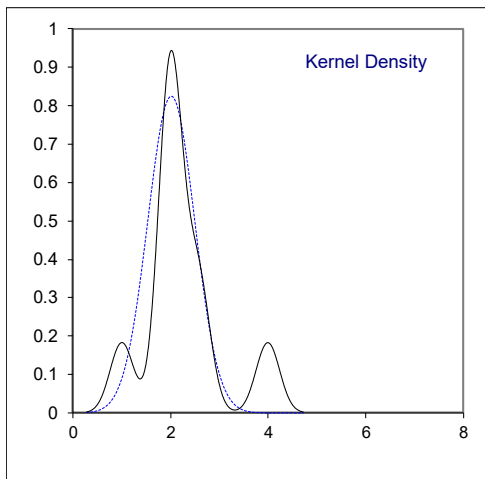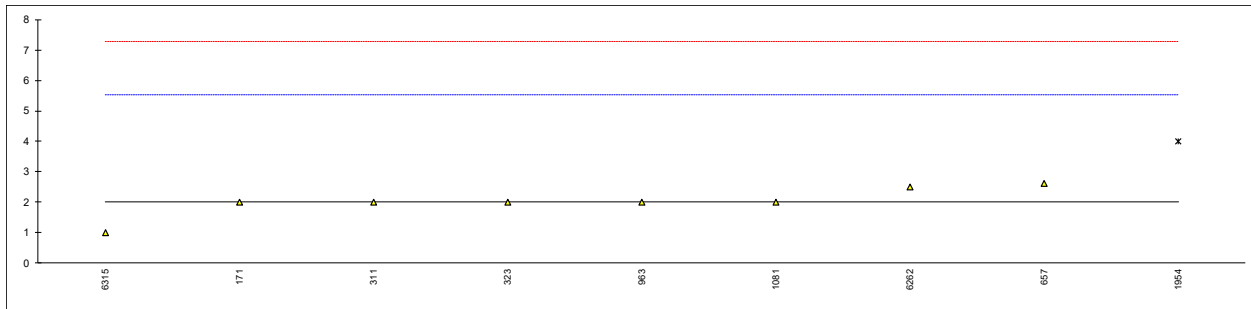
Determination of Density at 20°C on sample #20012; results in kg/L

lab	method	value	mark	z(targ)	remarks
171	D4052	0.7787		0.48	
311	D4052	0.7786		-0.08	
323	D4052	0.7785		-0.64	
657	D4052	0.77861		-0.03	
847		-----		-----	
859		-----		-----	
963	D4052	0.7785		-0.64	
1081		-----		-----	
1954	D4052	0.7786		-0.08	
6262	ISO12185	0.7789		1.60	
6315	ISO12185	0.77851		-0.59	

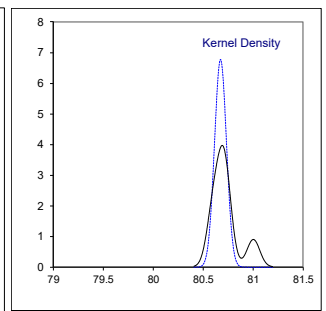|		
normality	unknown	
n	8	
outliers	0	
mean (n)	0.77861	
st.dev. (n)	0.000134	
R(calc.)	0.00038	
st.dev.(ISO12185:96)	0.000179	
R(ISO12185:96)	0.0005	
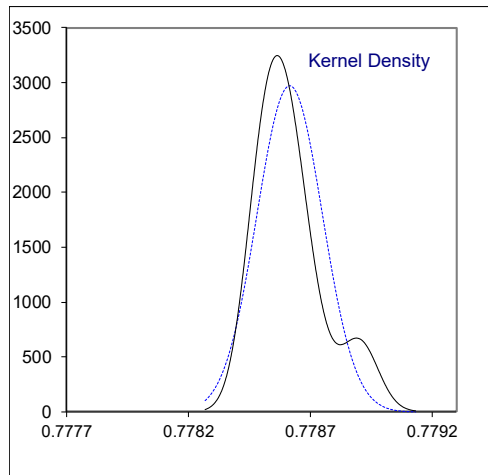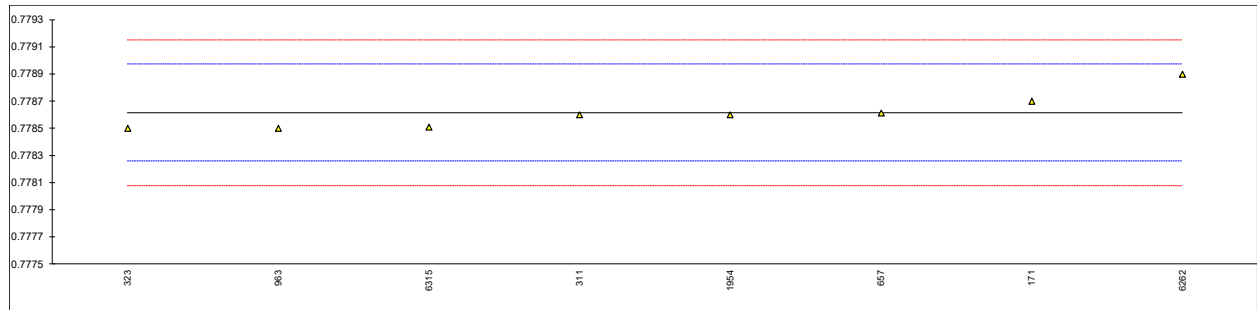
Determination of Distillation on sample #20012; results in °C

Lab	method	IBP	mark	z(targ)	50%	mark	z(targ)	DP	mark	z(targ)	range	mark
171	D850-A	79.4	G(0.05)	-4.77	80.7		0.48	80.7	C	-0.53	1.3	
311		-----		-----	-----		-----	-----		-----	-----	
323	D850-M	80.5		0.53	80.6		-1.32	80.7		-0.53	0.2	
657	D850-M	80.5		0.53	80.7		0.48	80.7		-0.53	0.2	
847		-----		-----	-----		-----	-----		-----	-----	
859		-----		-----	-----		-----	-----		-----	-----	
963	D850-A	80.35		-0.19	80.74		1.20	80.80		0.09	0.5	
1081		-----		-----	-----		-----	-----		-----	-----	
1954	D1078	80.2		-0.92	80.7		0.48	81		1.32	-----	
6262	D850-A	80.4		0.05	80.6		-1.32	80.6		-1.14	0.2	
6315	D850-A	81.0	G(0.05)	2.94	81.0	D(0.05)	5.86	81.0		1.32	0.0	
	normality	unknown			unknown			unknown				
	n	5			6			7				
	outliers	2			1			0				
	mean (n)	80.39			80.67			80.79				
	st.dev. (n)	0.125			0.059			0.157				
	R(calc.)	0.35			0.16			0.44				
	st.dev.(D850-A:18e1)	0.208			0.056			0.163				
	R(D850-A:18e1) *)	0.581			0.156			0.456				
Compare:												
	R(D850-M:18e1)	0.412			0.646			0.646				

*) precision data of Toluene is used

Lab 171 first reported 1.3 for Dry Point

Initial Boiling Point — Kernel Density

50% recovered — Kernel Density

Dry Point — Kernel Density
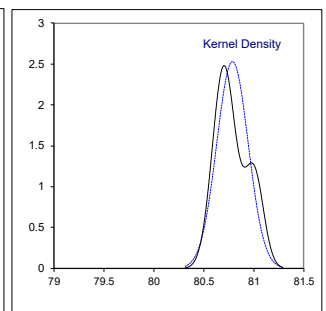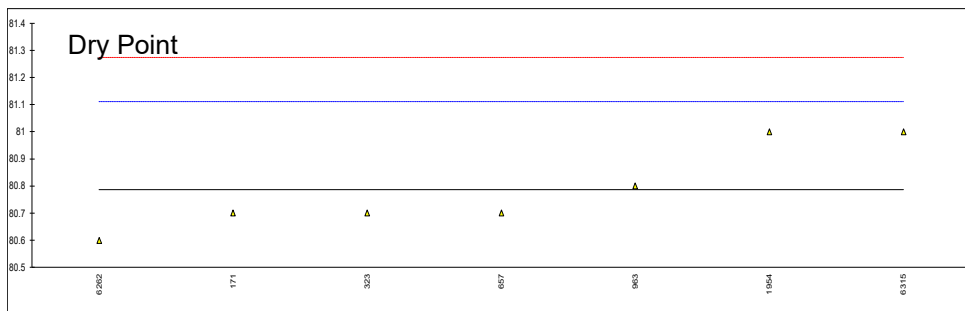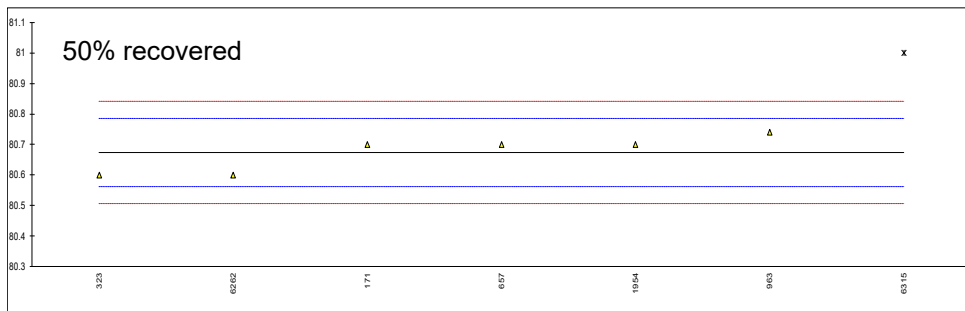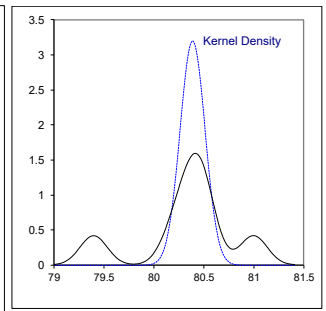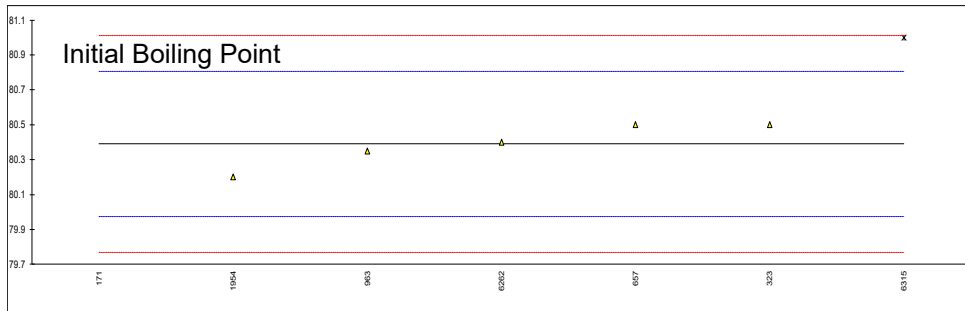
Determination of Freezing Point on sample #20012; results in °C

lab	method	value	mark	z(targ)	remarks
171		-----		-----	
311	D1493	6.30		-----	
323	D1016	6.4		-----	
657		-----		-----	
847		-----		-----	
859		-----		-----	
963		-----		-----	
1081		-----		-----	
1954		-----		-----	
6262		-----		-----	
6315					
	n	2			
	mean (n)	6.4			

Determination of Purity of Cyclohexane on sample #20012; results in %M/M

lab	method	value	mark	z(targ)	remarks
171	D7266	99.98		-0.57	
311	D3054	99.98		-0.57	
323	D7266	99.98		-0.57	
657	D7266	99.9838		1.03	
847		-----		-----	
859		-----		-----	
963	D7266	99.98		-0.57	
1081	D3054	99.983		0.69	
1954		-----		-----	
6262	D7266	99.9812	C	-0.07	first reported 99.97
6315	D7871	99.9828		0.60	

normality	unknown
n	8
outliers	0
mean (n)	99.9814
st.dev. (n)	0.00161
R(calc.)	0.0045
st.dev.(D7266:13e1)	0.00238
R(D7266:13e1)	0.0067

Kernel Density
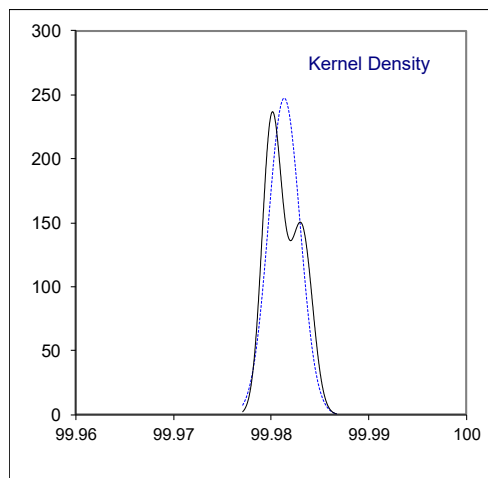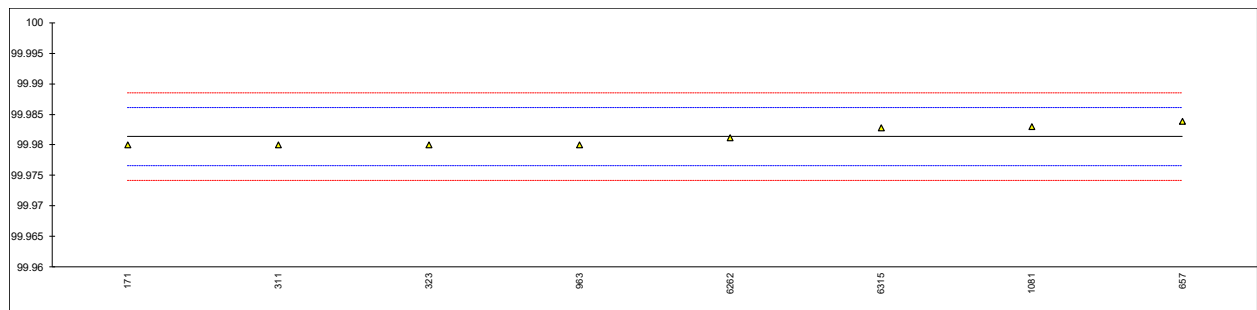
Determination of Benzene on sample #20012 in mg/kg

lab	method	value	mark	z(targ)	remarks
171	D7266	23		-0.20	
311	D3054	28		0.43	
323	D7266	23		-0.20	
657	D7266	23.0		-0.20	
847		-----		-----	
859		-----		-----	
963	D7266	15.2	D(0.01)	-1.20	
1081	D3054	25.11		0.07	
1954		-----		-----	
6262	D7266	26		0.18	
6315	D7871	24		-0.07	

normality	unknown
n	7
outliers	1
mean (n)	24.6
st.dev. (n)	1.91
R(calc.)	5.3
st.dev.(D7266:13e1)	7.85
R(D7266:13e1)	22.0

Kernel Density
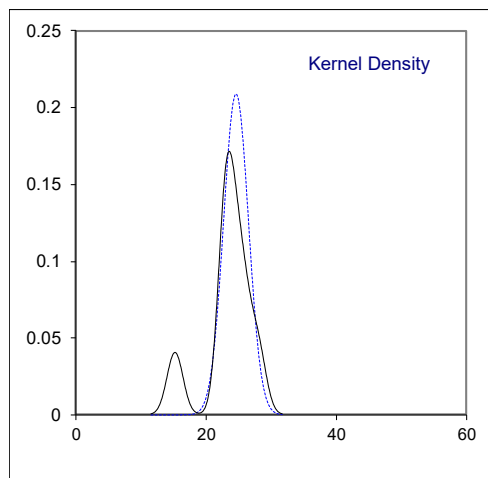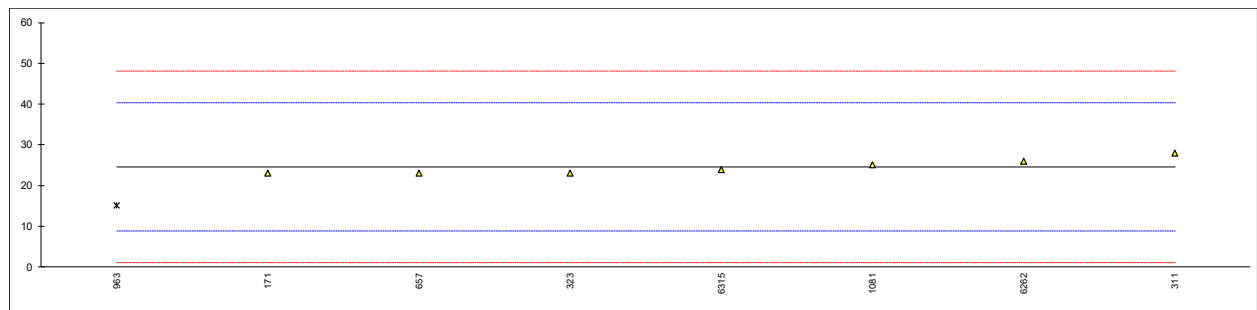
Determination of n-Hexane on sample #20012; results in mg/kg

lab	method	value	mark	z(targ)	remarks
171	D7266	3	C	-----	first reported 23
311	D3054	3		-----	
323	D7266	<5		-----	
657	D7266	2.8		-----	
847		-----		-----	
859		-----		-----	
963	D7266	2.47	C	-----	first reported 24.7
1081	D3054	2.86		-----	
1954		-----		-----	
6262	D7266	3		-----	
6315	D7871	3		-----	
	n	8			
	mean (n)	<5			

Determination of Methylcyclohexane on sample #20012; results in mg/kg

lab	method	value	mark	z(targ)	remarks
171	D7266	96		-0.08	
311	D3054	109		0.97	
323	D7266	96		-0.08	
657	D7266	89.6		-0.60	
847		-----		-----	
859		-----		-----	
963	D7266	88.8		-0.67	
1081	D3054	98.98		0.16	
1954		-----		-----	
6262	D7266	102		0.40	
6315	D7871	96		-0.08	

normality	unknown
n	8
outliers	0
mean (n)	97.0
st.dev. (n)	6.52
R(calc.)	18.3
st.dev.(D7266:13e1)	12.38
R(D7266:13e1)	34.7

Kernel Density
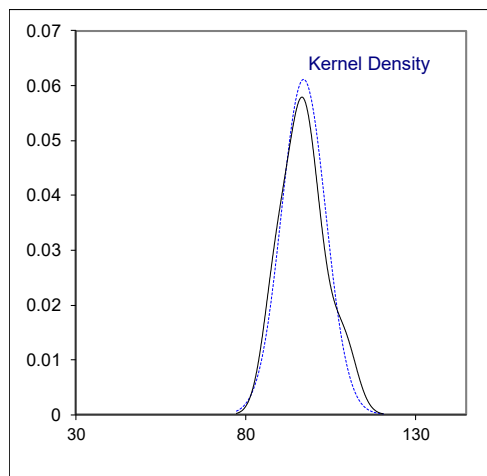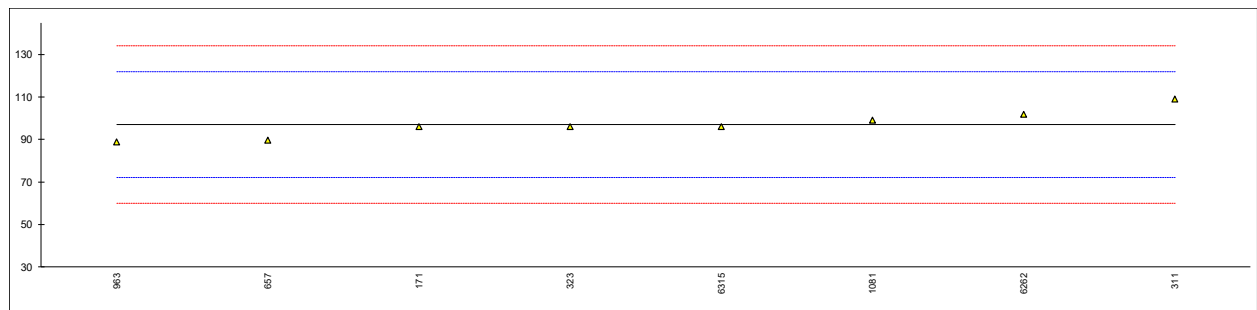
Determination of Methylcyclopentane on sample #20012; results in mg/kg

lab	method	value	mark	z(targ)	remarks
171	D7266	1		-0.05	
311	D3054	1		-0.05	
323	D7266	<5		-----	
657	D7266	1.1		0.03	
847		-----		-----	
859		-----		-----	
963	D7266	<1		-----	
1081	D3054	1.20		0.11	
1954		-----		-----	
6262	D7266	0	ex	-0.83	excluded as zero is not a real test value
6315	D7871	1		-0.05	

normality	unknown
n	5
outliers	0 +1ex
mean (n)	1.1
st.dev. (n)	0.09
R(calc.)	0.3
st.dev.(D7266:13e1)	1.28
R(D7266:13e1)	3.6
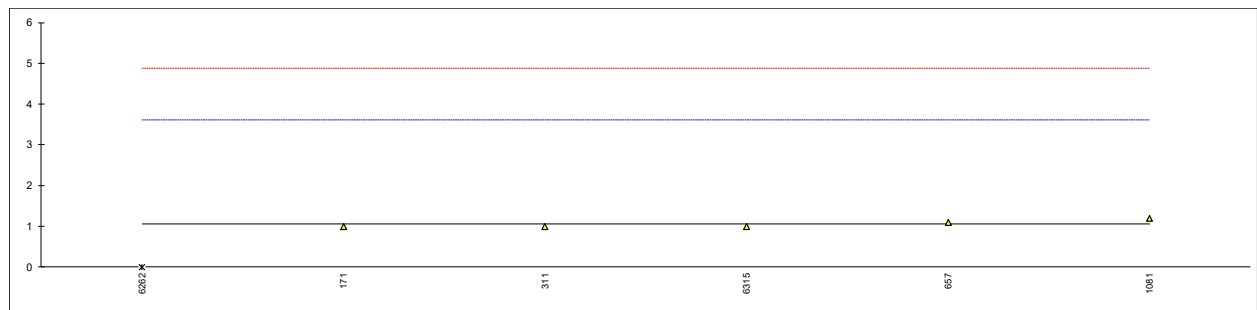
Determination of Refractive Index at 20°C on sample #20012;

lab	method	value	mark	z(targ)	remarks
171	D1218	1.4263		0.00	
311	D1218	1.4263		0.00	
323	D1218	1.4263		0.00	
657	D1218	1.4263		0.00	
847		-----		-----	
859		-----		-----	
963	D1218	1.4263		0.00	
1081		-----		-----	
1954		-----		-----	
6262	D1218	1.4263		0.00	
6315		-----		-----	

normality	
n	6
outliers	0
mean (n)	1.4263
st.dev. (n)	0.000000
R(calc.)	0.000000
st.dev.(D1218:12)	0.000179
R(D1218:12)	0.0005
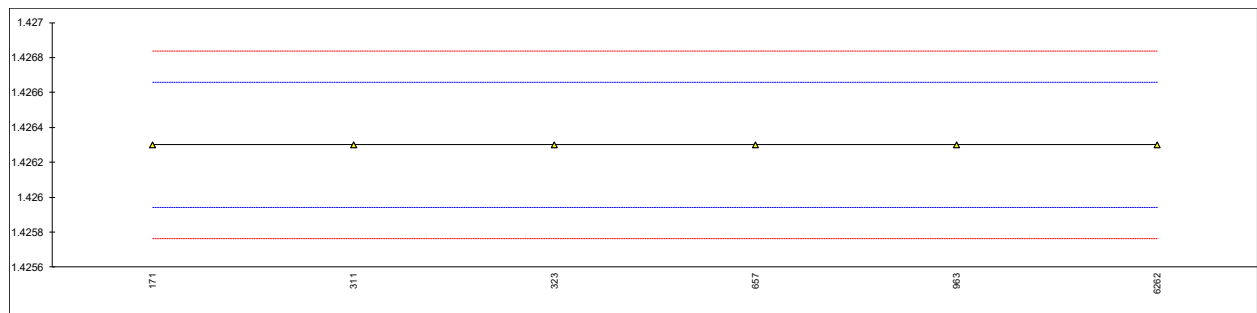
Determination of Sulfur on sample #20012; results in mg/kg

lab	method	value	mark	z(targ)	remarks
171		-----		-----	
311	D7183	<0.1		-----	
323	D7183	<1		-----	
657	D5453	0.02		-----	
847		-----		-----	
859		-----		-----	
963	D7183	<0.5		-----	
1081	D7183	0.01		-----	
1954	D7183	0.10		-----	
6262	D7183	0		-----	
6315	ISO20846	0.01		-----	
	n	8			
	mean (n)	<1			

APPENDIX 2

Number of participants per country

2 labs in　BELGIUM
2 labs in　CHINA, People's Republic
　1 lab in　GERMANY
　1 lab in　INDIA
2 labs in　NETHERLANDS
　1 lab in　SAUDI ARABIA
　1 lab in　SINGAPORE
　1 lab in　UNITED STATES OF AMERICA

APPENDIX 3

Abbreviations

C	= final test result after checking of first reported suspect test result
D(0.01)	= outlier in Dixon's outlier test
D(0.05)	= straggler in Dixon's outlier test
G(0.01)	= outlier in Grubbs' outlier test
G(0.05)	= straggler in Grubbs' outlier test
DG(0.01)	= outlier in Double Grubbs' outlier test
DG(0.05)	= straggler in Double Grubbs' outlier test
R(0.01)	= outlier in Rosner's outlier test
R(0.05)	= straggler in Rosner's outlier test
E	= possibly an error in calculations
W	= test result withdrawn on request of participant
ex	= test result excluded from statistical evaluation
n.a.	= not applicable
n.e.	= not evaluated
n.d.	= not detected
fr.	= first reported
SDS	= Safety Data Sheet

Literature

1   iis Interlaboratory Studies, Protocol for the Organisation, Statistics & Evaluation, June 2018
2   ASTM E178:02
3   ASTM E1301:03
4   ISO13528:05
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7   M. Thompson and R. Wood, J. AOAC Int, 76, 926, (1993)
8   W.J. Youden and E.H. Steiner, Statistical Manual of the AOAC, (1975)
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12   J.N. Miller, Analyst, 118, 455, (1993)
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14   P.J. Lowthian and M. Thompson, The Royal Society of Chemistry 2002, 127, 1359-1364 (2002)
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